GRAINS FOR THE UTAH DRY LANDS

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UTAH soils in general are suitable for dry farming, and the rainfall usually is sufficient to grow one crop in two years. The principal crop is winter wheat, which is grown in alternation with summer fallow. Winter emmer, barley, and oats and spring barley and oats also may be grown.

To produce the best yields of winter wheat and other grains at the least expense, plow the land in the spring and maintain a clean fallow during the summer. Sow between September 15 and October 15 at a depth of 2 to 3 inches. Sow winter wheat at the rate of 5 pecks and winter emmer, oats, and barley at from 6 to 8 pecks per acre. Spring wheat, oats, and barley, where it is necessary to grow these crops because of the failure of fall-sown grains, should be sown as early in the spring as the land can be put in condition for seeding.

The best varieties are Crimean, Turkey, and Kharkof winter wheats, Black Winter emmer, Boswell Winter oats, and White Club and Tennessee Winter barleys. Of the spring varieties the best are Ghirka Spring and Marquis wheats, Swedish Select oats, and Coast, Mariout, and White Smyrna barleys.

Corn, the grain sorghums, proso, and flax have been grown in a very limited way and can not be recommended generally. Corn and the grain sorghums may prove to be of value in certain localities.

GRAINS FOR THE UTAH DRY LANDS.

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DRY-LAND SECTIONS OF UTAH.

DURING the last 15 years the dry lands of Utah have been rapidly taken under the homestead law or have been bought from the State. Most of this land is owned by people who were either unable to obtain irrigated land or who wanted a dry farm in addition to their irrigated land. The first few years that dry farming was practiced profitable crops were not produced every year. Failures were not infrequent, but thorough tillage and careful observation finally made dry farming a success. Many of the practices, however, were based on theories rather than on fundamental principles evolved from carefully conducted experiments. Reliable information regarding the best crops and the methods of growing them on dry farms has always been in demand.

This bulletin presents the best available information on the small-grain crops and varieties adapted to Utah dry lands and the cultural operations necessary to produce them. The information is based largely on experiments conducted during the last nine years at the Nephi substation.[1] This substation is located in the Juab Valley, in Juab County, which is about the geographical center of the State. The principal crops discussed are winter wheat, spring wheat, emmer, oats, and barley.

[1] The Nephi substation was established in 1903 by the Utah Agricultural Experiment Station. Since 1907 the experiments there have been conducted cooperatively by the Utah station and the Bureau of Plant Industry of the United States Department of Agriculture. These experiments have been reported in detail in the following publications:

Farrell, F. D. Dry-land grains in the Great Basin. U. S. Dept. Agr., Bur. Plant Indus. Circ. 61, 39 p., 2 pl. 1910.

Cardon, P. V. Cereal investigations at the Nephi substation. U. S. Dept. Agr. Bul. 30, 50 p., 9 fig. 1913.

——— Minor dry-land crops at the Nephi experiment farm. Utah Agr. Exp. Sta. Bul. 132, p. 347–378, 7 fig. 1914.

——— Tillage and rotation experiments at Nephi, Utah. U. S. Dept. Agr. Bul. 157, 45 p., 21 fig. 1915.

Harris, F. S., and Ellison, A. D. Dry farming in Utah. Utah Agr. Exp. Sta. Circ. 21, 35 p., 15 fig. 1916.

The dry-land sections of Utah are not located in any distinct geographic portion of the State. The whole State is naturally arid. A small percentage of the land can be reclaimed by irrigation: the remainder, if farmed at all, must be cropped by dry-farming methods. The acreage adapted to dry farming is limited, however, as a large

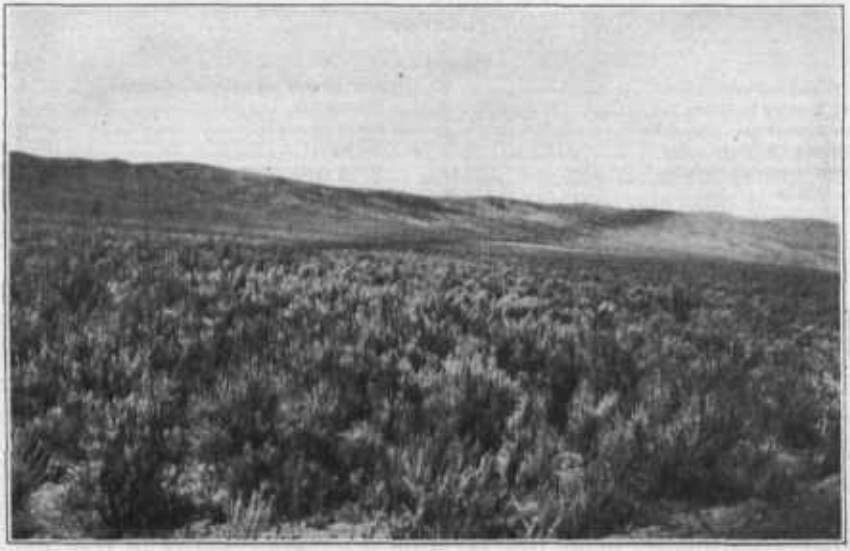

FIG. 1.—A typical Utah mountain valley landscape, showing land suitable for dry farming. The abundant growth of sagebrush indicates a fertile soil and a rainfall sufficient for crop production if properly utilized.

part of the State is mountainous. In many districts which are otherwise arable the annual precipitation is so low that they can not be farmed successfully except by irrigation. The lower lands in the mountain valleys are usually irrigated if the water supply is sufficient, while the lands above the canals must be dry farmed or not farmed at all.

TOPOGRAPHY.

Most of the land in the State where the rainfall is sufficient to mature one crop in two years and that is not too rough for the ordinary cultural operations is dry farmed. Usually this land is above "high-line" canals or is so located that irrigation is otherwise impossible. Much of this dry-farmed land is quite smooth, with a gradual slope toward the center of the valley. In some sections, however, the land is badly broken by ravines; in others, hills and hollows are numerous. A typical landscape in a Utah mountain valley is shown in figure 1. The abundant growth of sagebrush shown in this illustration indicates a fertile soil and a rainfall sufficient for crop production if properly utilized.

SOILS.

The soil types in the State vary from light sand to heavy clay, with clay loam predominating. Considerable acreages of sandy soil will never be successfully dry farmed because of low moisture-holding capacity, high evaporation, and low precipitation. Neither are the heavy clays ideal for dry farming, because of their hardness, tendency to bake, and lack of response to cultural operations. The most nearly ideal dry-farm soil is one which is uniform to a considerable depth, with enough sand to make it easily tillable and enough clay to insure the retention of sufficient moisture for crop production. Utah has a large acreage of just such soils, unbroken by gravel or hardpan. The fertility of these soils is best shown by their crop production in normal years. Because of the low rainfall the mineral elements of plant food naturally in the soil have not been removed by leaching. Crop production on these soils is limited only by the available water.

CLIMATE.

Climatic conditions vary in different parts of Utah. In the southern part of the State the growing season is longer than in the north; in fact, rather wide variations often occur in a single mountain valley. Canyon breezes and good air drainage help to prevent frost injury in some locations when in other near-by locations frost damage is severe.

RAINFALL.

Successful and profitable crop production on arid land depends largely on the amount and distribution of the rainfall. About 85 per cent of the annual precipitation in Utah falls between October and April. As the bulk of the precipitation comes during the winter and early spring months, this moisture must be stored in the soil if it is to be of use to growing plants. A low annual precipitation favorably distributed is often more efficient than a high precipitation poorly distributed.

The annual rainfall in Utah varies from 3.71 inches at Wendover, Tooele County, to 19.30 inches at Henefer, Summit County. At Nephi the average annual precipitation for the past 19 years is 13.56 inches. In Tooele County the precipitation varies from 3.71 inches at Wendover to 15.93 inches at Lovelle; in Box Elder County, from 6.5 inches at Kelton to 12.5 inches at Corinne. These examples clearly show the marked variations that occur in the precipitation in a relatively small area; hence the necessity of knowing the distribution of the normal precipitation for each locality.

EVAPORATION.

Evaporation is an important factor in crop production on the dry lands. A section with high evaporation and high precipitation may not produce any better crops than a section with a low evaporation and low precipitation, other conditions being equal. Evaporation in a measure determines the efficiency of the precipitation. The evaporation in Utah is rather high, so that a relatively high precipitation or a soil with good moisture-holding capacity is necessary for profitable crop production. The evaporation from a free water surface at the Nephi substation for the seven months from April to October, inclusive, has averaged 48.9 inches during the past nine years. This is about the same as the average evaporation for the same months in the central Great Plains and in the Columbia Basin.

TEMPERATURE.

The temperature varies in different parts of the State, being lower at the higher than at the lower elevations. The annual mean temperature, based on records from 26 stations, is about 49.5° F. The annual mean temperature ranges from 43.6° at Emery, located on the western edge of Emery County, at an elevation of 6,260 feet, to 59.8° at Hite, on the Colorado River, in Garfield County, at an elevation of 3,000 feet. Temperatures well below zero are usually recorded at intervals during the winter months. Minimum temperatures as low as —25° and —30° F. are sometimes recorded at the higher elevations. Maximum temperatures of 100° F. or more are sometimes recorded during June, July, and August, especially at the lower elevations.

The frost-free period varies from year to year and also varies widely with the altitude. The growing season is comparatively short, the period from the last frost in spring to the first frost in fall usually ranging from 110 to 150 days. At Nephi the average frost-free period is 104 days, with a minimum in the past nine years of 69 days and a maximum of 142 days.

DRY FARMING IN UTAH.

Utah is usually looked upon as the pioneer State in dry farming. Attempts at dry farming were made soon after 1850, but little success was attained until about 1890 or later. In 1903 experimental work in dry farming began in Utah.

Lack of irrigation water and the slow development of irrigation projects forced the earlier settlers to the dry lands. The change in the homestead law which allows the taking up of 320 instead of 160 acres added impetus to the dry-farm movement. The land suitable for dry farming has been rapidly settled during the past decade. A

large part of the tillable dry land in Utah has been brought under cultivation, especially that which lies close to railroads and markets. There is still considerable land in isolated sections that may in time be profitably cultivated. As land becomes scarcer the home seekers are forced farther and farther into these isolated districts. The best lands are taken, so that one's choice is now limited. The problem confronting the dry farmer is not one of using good judgment in selecting his farm, but of making the best of the conditions as he finds them.

DRY-FARM CROPS.

Winter wheat always has been and probably always will be the leading crop grown on the Utah dry farms. It is admirably adapted to the system of alternate cropping and fallowing as practiced in Utah. It has a higher value per unit of bulk than other dry-land crops. It is easily transported, is always marketable, and gives a ready cash return. The growing of oats, barley, and other feed crops has increased as the live stock on the farms have increased. Further diversification of crops on the Utah dry farms is practically impossible, because winter wheat is the only profitable crop that is generally adapted to the dry lands. Other crops may be profitable in some sections.

GROWING THE GRAIN CROPS.

It is impossible to give definite directions for growing cereals over an extensive area, because of soil and climatic variations. The directions herein given for growing cereals on the Utah dry farms are general rather than specific and must be modified by local conditions and experience.

PREPARATION OF THE SEED BED ON NEW LAND.

Virgin land in Utah is usually covered with a growth of sagebrush. Special implements for removing this brush are manufactured, but none of them is entirely satisfactory because (1) they are too expensive and (2) they do not always do good work. "Railing" is the most satisfactory method of clearing brush land. When the brush is dry, two railroad rails, one fastened behind the other, are dragged over the land two or three times. This breaks most of the sagebrush and it can then be gathered into windrows with a spike-tooth harrow or an ordinary hayrake and burned. The use of the spike-tooth harrow in completing the clearing of brush land is shown in figure 2. The best time to do the work is in the fall. New land may be plowed either in the spring or in the fall. The plowing should be from 5 to 8 inches deep. If plowed in the fall the land should be left rough until spring. Clean cultivation during the summer will put it in good condition for fall seeding. If the land is spring plowed and is to be sown to grain the following fall it must

FIG. 2.—Removing with a spike-tooth harrow the last of the sagebrush roots from a field, preparatory to breaking for wheat.

be worked down immediately after plowing and kept free from weeds until seeding time. Disking and harrowing are the most effective operations in preparing land for seeding. Except in localities of high rainfall or in wet seasons it is not advisable to seed the same year that the land is broken. It should be fallowed one season to insure the storage of sufficient moisture for crop growth.

PREPARATION OF THE SEED BED ON STUBBLE OR OLD LAND.

Old land may be plowed either in the fall or spring. On large farms it is good management to plow part of the land in the fall and the remainder in the spring, thus keeping the farm equipment busy. Land that is to be seeded in the spring should be fall plowed and left rough during the winter. The rough, cloddy surface helps to catch and hold the moisture. This land works down readily in the spring. The land should be plowed 5 to 8 inches deep. Plow only when the land is in good condition for the work. Good plowing does not necessarily mean deep plowing, but means that the land should be turned evenly, covering all trash, weeds, and stubble. Results at the Nephi substation show that deep plowing is not essential to success on Utah dry farms; in fact, subsoiling is distinctly unprofitable. A traction engine with 12 disk plows attached at work in a stubble field is shown in figure 3.

Spring plowing for fallow at Nephi has been found more profitable than fall plowing. Spring-plowed land should be harrowed as soon as possible after plowing, preferably the same day it is plowed.

Spring plowing for fallow should be done as soon as weeds and volunteer grain begin growth, thus eliminating the weed problem to a large extent. The disk and spike-tooth harrows are the most commonly used implements on plowed land. Do not use the disk harrow too often; frequent use fines the surface soil too much. In killing weeds some kind of knife weeder or spring-tooth harrow should be used. Floats are used to level the land before sowing.

A firm seed bed with a fine mellow surface to a depth of 2 to 3 inches is best. The disk harrow, except when used for packing, causes the soil to dry to too great a depth. If spring plowing is to be sown to spring crops, disk to pack the land and then harrow as soon as possible. If the spring-plowed land is intended for fall-sown grain, harrow after plowing. Disking is not necessary, as the summer rains will pack the land sufficiently before fall seeding.

Unsupported theory has no place in farm practice. Returns count. At Nephi, spring plowing is cheaper than fall plowing, because (1) it eliminates weeds and volunteer grain, thus reducing the cost of maintaining the fallow; (2) yields on spring plowing are as high as those on fall plowing; (3) land is in better condition for plowing in the spring than in the fall; and (4) average results in the past eight years show that more moisture has been stored in the upper 6 feet in spring-plowed than in fall-plowed plats.

FIG. 3.—Breaking stubble land for fallow with a traction engine and disk plows on a Utah dry-land farm.

SUMMER FALLOW.

Summer fallowing has been practiced in Utah since the earliest days of dry farming in the State. Fallow land is plowed in the fall or spring and by cultivation is kept free from all growth during the fallow season. The purpose of fallow is to store moisture for the crop that is to follow. This is an expensive practice, but in Utah it is necessary in most of the dry-farmed sections. Alternate fallow and cropping is the usual practice. Experimental results at Nephi show that fallowing every third year gives better returns than fallowing in alternate years. In sections with a precipitation of 15 inches or more, fallowing every third year is probably sufficient. Land that is to be spring plowed for fallow should be plowed as soon as the weeds and volunteer grain start growth. Harrow immediately after plowing. Use a knife weeder to eradicate scattered weeds that may appear later in the season. It is better to grow a crop of wheat than a crop of weeds. Do not pulverize the soil too much by frequent cultivation. Keep a clod rather than a dust mulch on the surface. Clod mulches blow less and are less likely to puddle than dust mulches. The purpose of a fallow is to store moisture. Moisture is not saved on a weedy fallow.

Late spring plowing results in the loss of much moisture by allowing plant growth. Fall plowing for fallow is probably advisable in some localities. It should be left rough until spring and then cultivated with the disk and spike-tooth harrows to kill weeds and conserve moisture. Weeds are most easily killed when they are young.

In some dry-farmed sections tilled crops are good substitutes for fallow in alternation with the small grains. Where winter wheat is important the cultivated crops do not lend themselves so readily to such a system. On the dry farms, winter wheat is usually sown early, before the cultivated crop is ready for harvest. With spring-sown cereals the tilled crop fits in much better. Winter wheat is the leading crop on the Utah dry farms, and no profitable tilled crop has yet been found to replace the fallow. Corn does well on some of the light dry-farm soils, but it is not commonly grown as a substitute for fallow. The average yields of winter wheat grown after peas, corn, and potatoes were almost identical with the yields of that grown after fallow at the Nephi substation. These tilled crops, however, were not profitable in themselves. Where tilled crops are grown the land merely is disked before seeding to a cereal crop. This cheap seed-bed preparation for the cereal helps to reduce the cost of the practice. Fallowing, although expensive, is less expensive than growing tilled crops, including the cost of seed and the labor of sowing and harvesting.

GOOD SEED.

CLEANING AND GRADING.

Low yields are often due to the use of poor seed. The use of good seed pays. Only plump well-filled grain should be sown. The seed grain should be carefully graded with a fanning mill, and trash, weed seeds, broken and shriveled kernels and smut balls removed. Use only those varieties that are known to be adapted to your locality. Then use the best seed of the best known variety. Do not sow irrigated varieties on dry land or spring varieties in the fall. Use as nearly pure seed as possible; mixtures ripen unevenly and loss from shattering during harvest results. Mixed wheat is often docked on the market, especially if the mixture consists of hard and soft varieties.

Farmers often remark that their seed is running out and that they need a better grade of seed from some outside source. Experiments at the Nephi substation show that wheat grown at Nephi is as good for seed as wheat shipped in from Oregon or Montana. It is true that crops deteriorate if not properly cared for, but grain does not run out if selected and graded before sowing. Local seed should become more valuable each year that it is grown. Many experiments show that yellow berry can not be controlled by selection. This inferior quality is due to a combination of climatic and soil conditions.

TREATING THE SEED FOR SMUT.

The most common diseases of cereals in Utah are the smuts. The cereal smuts can be controlled to a large extent by treating the seed. The most common smuts are the stinking smut of wheat, the smut of oats, and the covered smut of barley. The formaldehyde treatment is the one most frequently used to combat these diseases. The proper strength of the solution is 1 pound of 40 per cent commercial formaldehyde to 40 gallons of water. The formaldehyde may be purchased at any drug store. Either of the three following methods is effective:

(1) After running seed grain through a fanning mill to remove smut masses, spread it on a clean floor or a tarpaulin and sprinkle the formaldehyde solution over the grain. The grain should be stirred thoroughly while being sprinkled, and the process should be continued until every kernel is wet. Then cover the grain with a canvas or some other heavy material and allow it to lie one hour. It should then be uncovered and stirred occasionally until dry. It is then ready for seeding.

(2) Prepare the formaldehyde solution in barrels. Put the grain to be treated in burlap sacks after it has been fanned to remove smut masses. Fill the sacks about half full and immerse them in the solution for 10 minutes; then hang them up to drain and dry. The sacks should be shaken occasionally to hurry the drying process.

(3) When all the smut balls are not removed by the fanning process it is advisable to immerse the seed in a formaldehyde solution. There are several

methods of doing this, one of the most convenient of which is as follows: A hole is bored in the side near the bottom of each of two tubs or half barrels with handles. This hole is fitted with a plug and covered with a wire screen on the inside of the tub, so that grain can not pass through. One tub is set above the other. The upper tub is then filled two-thirds full with the formaldehyde solution and the seed poured in. As the seed is poured in and stirred, smut balls, chaff, and light kernels rise to the surface and are skimmed off. When the skimming is completed the plug is removed, and the formaldehyde solution is allowed to drain into the tub beneath. The grain is then removed and spread out to dry. The empty tub is placed on the ground, the other tub on the stand, and the process is continued, more of the solution being added when necessary.

A convenient modification of this method is to provide two tubs, a large one and a smaller one, the latter made of substantial wire mesh or of iron or tin with perforated plate or wire bottom. The larger tub is two-thirds filled with the formaldehyde solution; the other tub is set down in it and the grain poured in and stirred. The smut balls and foreign material will rise to the surface and can be skimmed off. When this is done the smaller tub containing the grain can be removed from the solution, which is allowed to drain off, and the grain is emptied on the floor and dried.

In treating grain, care should be taken to have the solution the right strength. If too weak, it will not kill the spores. If too strong, it will injure the grain. Be sure the formaldehyde you buy is full strength. Wash out the drill with the formaldehyde solution. This

FIG. 4.—Harvesting wheat with a large combined harvester and thrasher on a Utah dry-land farm.

FIG. 5.—Harvesting wheat with a small, or "Idaho," combined harvester and thrasher on a Utah dry-land farm.

will destroy any smut spores that may be in it. For a more complete discussion of the smuts of grain and of smut treatments, see Farmers' Bulletin 507, "The Smuts of Wheat, Oats, Barley, and Corn."

SEEDING.

The best rates, dates, and methods of seeding the various small grains will be discussed for each crop separately in the pages which follow.

HARVESTING.

The grain crops are usually harvested in one of three ways—(1) with combines, (2) with headers, or (3) with binders.

The combines are not used extensively in Utah, though conditions are favorable for their use. Grain must be fully ripe before it is harvested with a combine, but standing grain in this State is not likely to shatter or be damaged by hail, rain, or wind storms. Combines in the past have been large, expensive machines, and were practical only on the large farms. Small combines are now being manufactured, which undoubtedly will be more popular in Utah than the big ones have been. A large combine in operation is shown in figure 4 and a small one in figure 5.

Most of the wheat in Utah is cut with headers. These machines cut off the heads and elevate them directly into header boxes, from which they are stacked. A header in operation is shown in figure 6

and stacks of headed wheat in figure 7. Stacks should be well built to shed rain. The advantages of the header are:

(1) It leaves most of the straw on the ground.
(2) Large acreages can be harvested quickly.
(3) Thrashing can be done when other work is slack.
(4) The field is ready for plowing or other cultivation early in the season.
(5) Grain can be hauled directly from the thrasher to the elevator without being sacked.

These are points that are worthy of attention when methods of harvesting are being considered. Oats are usually cut with the binder rather than the header, as much of the grain is lost by shattering if this crop is left until ripe enough to harvest with the header.

Thrashing from the shock is more expensive than thrashing from the stack. The binder is useful on small fields, but it is not as suitable for harvesting in Utah as the header or small combines.

GRAIN CROPS AND VARIETIES.

WHEAT.

Wheat is the most important dry-farm crop in Utah. The climate and soil are generally favorable for wheat growing. There is always a ready market for wheat, and it is the best adapted cash crop on

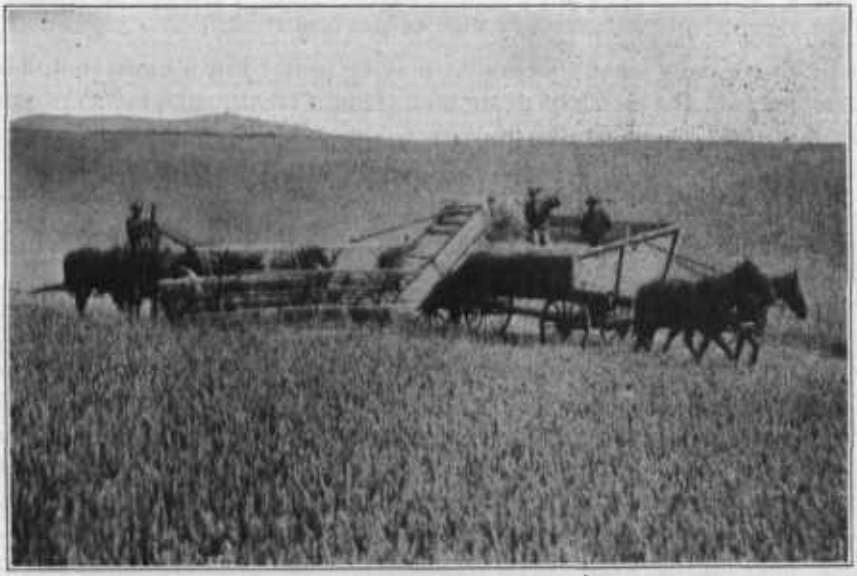

FIG. 6.—Cutting wheat with a header in Utah.

the dry farms. It has a relatively high value per unit of bulk and is easily and cheaply handled. For these reasons it can be profitably grown at a considerable distance from market. In 1916 there were 326,000 acres of wheat grown in Utah. This area produced 6,900,000 bushels of wheat.

WINTER WHEAT.

In 1916 there were 5,000,000 bushels of winter wheat produced in Utah, as compared with 1,900,000 bushels of spring wheat. The average production of winter and spring wheat in the State in the five years from 1911 to 1915, inclusive, was 4,628,000 and 1,973,000

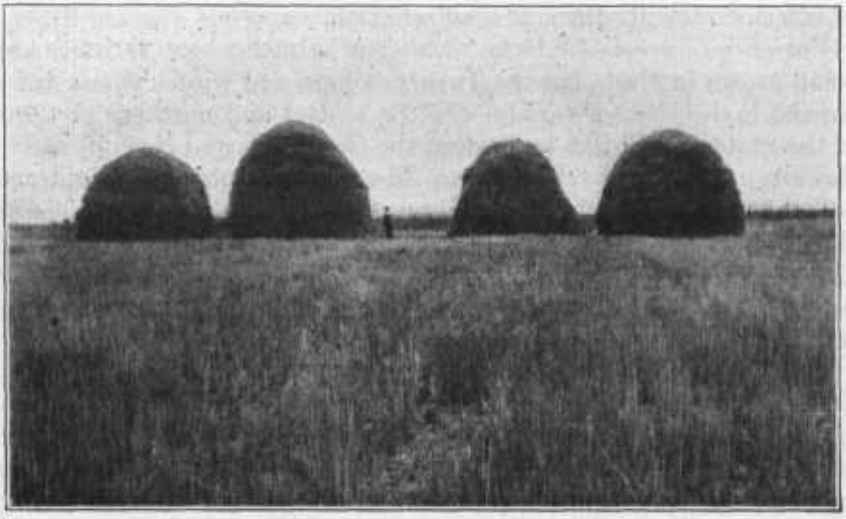

FIG. 7.—Stacks of headed wheat awaiting thrashing on a Utah dry-land farm.

bushels, respectively. Winter wheat is adapted to practically all sections of the State. Winterkilling occurs in some districts, but where it can be grown winter wheat yields considerably more per acre than spring wheat. Most of the spring wheat is grown under irrigation, but when fall wheat winterkills on the dry farms the land is often reseeded to spring wheat. Winter wheat matures from 10 days to 2 weeks earlier than the spring varieties. Its earliness often enables it to escape the most serious effects of summer droughts, which seriously injure spring wheat. Winter wheat stands up better than spring wheat on Utah soils.

With the exception of 1916, when the yield per acre was lower than usual, there has been a gradual increase in the wheat production of Utah since 1912. Most of this increase has been winter wheat. The average increase in the past five years has been about 25,000 acres annually.

The varietal experiment at Nephi shows that the soft white winter wheats are inferior in yield to the Crimean group of hard red winter wheats. Some farmers, however, have reasons other than yield which they think justify them in growing the soft white varieties. The Koffoid and Gold Coin are the leading varieties in the soft white group in Utah. These wheats were at one time the most popular varieties in the State. The hard red wheat brings a better market

price than the soft white wheat, but both soft and hard wheat are needed by millers for blending purposes.

Wheat varieties in Utah are badly mixed. Often a field is a mixture of seven or eight distinct types. Some of these may be hard, others soft. Such a condition makes it difficult to obtain reasonably pure seed. Yields and profits could be increased by the elimination of inferior varieties through seed selection.

Varieties to grow.—A large number of winter-wheat varieties are being grown in Utah, but the Turkey, a hard red winter wheat from Russia, is the leading variety. In the central and northern sections of the State, in addition to Turkey, the Gold Coin and Koffoid varieties are quite extensively grown. The Gold Coin and Koffoid are beardless, brown-chaffed, white-kerneled varieties. Many farmers object to Turkey wheat because it is unpleasant to handle on account of its beards. Another objection is that the beards make the straw less suitable for feeding. This latter objection is justifiable when feed is scarce.

In a varietal experiment with winter wheat at the Nephi substation during the 9-year period from 1908 to 1916, inclusive, seven of the eight leading varieties belonged to the Crimean group of bearded, white-chaffed winter wheats with hard red kernels. The leading varieties in this experiment were the Turkey, Crimean, Bulgarian, and Kharkof. The Ghirka Winter, which ranked fifth in yield, is a beardless, white-chaffed variety with hard red kernels.

Seeding.—The best date to sow winter wheat is influenced by numerous conditions. In Utah, winter wheat should be sown early enough to allow some growth before winter. As a general rule, early seeding is practiced and recommended when soil and moisture conditions allow. Too much fall growth is not desirable, because the wheat may reach the jointing stage before winter or the spring growth may be so rank that all the available moisture is exhausted before the crop matures. On most Utah dry farms it is not possible to hold the moisture near enough to the surface to allow seeding at the desired time. Early seeding is done with the expectation that the rains will bring up the crop; otherwise, sowing is delayed until there is sufficient moisture to germinate the seed and support growth. Better stands are usually obtained from sowing after the rains. Results during the past 13 years show that the best yields have been obtained from sowing between September 15 and October 15.

Three pecks is the common rate of seeding wheat on Utah dry farms. While 3 pecks may be sufficient when moisture conditions are favorable at seeding time, experimental data indicate strongly the necessity for sowing at a heavier rate.

Eight years' results at the Nephi substation show that the best yields were obtained by sowing at the rates of 5 and 6 pecks per acre.

If the seed is sown early in dry ground, it is better to seed at this rate. Then, if some of the kernels fail to germinate and others that do germinate are crusted under, the stand will probably be about right, whereas if seeding is done at a lower rate poor stands result. Again, if seeding is done late in the fall, sow 5 or 6 pecks per acre, because many of the plants will probably winterkill and heavy seeding will insure a better stand. The best rate of seeding is dependent upon the date of seeding and the condition of the soil at seeding time. If the soil is dry or if seeding is done late in the fall, sowing 5 or 6 pecks per acre is recommended. If the time and conditions are more favorable, sow at the rate of 3 or 4 pecks per acre. Increase the rate for treated grain that has not been thoroughly dried.

The best results were obtained at Nephi by seeding from 1 to 3 inches deep. Yields decreased with increased depths of seeding. On a lighter soil, favorable results may be obtained by deeper seeding.

The best date, rate, and depth to sow winter wheat vary from year to year. They are determined largely by the kind of soil and its condition and by the climatic conditions during the fall months.

Cultivation of the growing crop.—The practice of harrowing winter wheat in the spring has been advocated quite generally in Utah. Some farmers think that it pays to harrow in the spring, while others do not. Harrowing is intended to break the surface crust, destroy weeds, and conserve moisture.

Experiments at Nephi during the past seven years show that harrowing winter wheat in the spring was not profitable. Like results were reported by the substations at Aberdeen, Idaho, and Moro, Oreg. In consideration of this evidence, harrowing winter wheat in the spring on Utah dry farms is not recommended.

SPRING WHEAT.

Only about one-fourth of the wheat grown in Utah is spring sown, and most of this is grown under irrigation. Spring wheat on the Utah dry farms is a minor crop, and in most cases it is used simply as a filler where fall wheat has winterkilled. Spring wheat is not profitable on the dry farms in comparison with winter wheat. The average yields of the leading winter wheats at Nephi are more than twice those of the leading spring wheats. In some limited sections it may be impossible to grow winter wheat because of late spring frosts. In these localities spring varieties may perhaps be substituted. Spring varieties should not be grown where winter varieties are successful.

It is more difficult to mention known and adapted varieties of spring wheat than of winter wheat, because the former are not grown extensively either commercially or in an experimental way. The Pacific Bluestem, Red Chaff, New Zealand, Sonora, Defiance, Ghirka

Spring, and Marquis are among varieties that have given the best results on the Utah dry farms. Red Chaff and Sonora have about disappeared from cultivation, while Sonora is a poor milling wheat. Kubanka is the leading spring durum wheat for Utah dry farms. At the Nephi substation the durum wheats have yielded better than the spring common varieties. However, there is no ready market for durum wheat grown in Utah. Local flour mills are not equipped to grind durum wheat and there is not enough grown to attract outside buyers. At the Nephi substation Ghirka Spring and Marquis are the leading spring common varieties.

Spring wheat should be sown as early as possible at the rate of 3 to 4 pecks per acre, to a depth of 1 to 3 inches. Durum spring wheats should be sown at the rate of 4 to 5 pecks per acre. The durum varieties do not stool as much as the common spring varieties; hence more seed should be sown.

EMMER.

In general, emmer is grown only experimentally in Utah. A few farmers, however, are growing this crop on a commercial scale for seed. Emmer is well adapted to Utah dry lands, but the crop is not generally grown, as there is no ready market for it. The winter varieties are more popular and better adapted to Utah conditions than the spring varieties. Winter emmer is hardy and drought resistant, but is not as hardy as winter wheat.

Black winter emmer is the best known and most commonly grown variety. At Nephi the 9-year average acre yield of this emmer was 37 bushels of 32 pounds each. This is a larger yield in pounds per acre than was produced by either barley or oats.

Winter emmer should be sown at the rate of 6 to 8 pecks per acre on the oat side of the drill. Sow when moisture conditions are favorable for germination, covering the seed 1 to 3 inches deep. Good fall growth is desirable. Emmer is an excellent stock food, especially for hogs and sheep.

OATS.

Most, if not all, of the oats grown on the Utah dry farms are used for feed. During the five years from 1912 to 1916 the area sown to oats in Utah increased from 91,000 acres in 1912 to 103,000 in 1916. The lowest yield during these years was 4,140,000 bushels in 1913 and the highest, 4,750,000 bushels in 1914. A considerable part of this crop was grown on irrigated land.

WINTER OATS.

Winter oats are grown to some extent on the dry farms, but as a rule this crop is uncertain because of winterkilling. The Boswell

Winter oat is the only variety that is grown commercially on Utah dry farms. The Winter Turf, however, is a promising variety.

The Boswell Winter is a local name for a black winter oat introduced into Utah from England a number of years ago by Mr. Stephen Boswell, of Nephi. Its black hull lowers its market value but does not affect its feeding value. The 8-year average yield of Boswell Winter oats at Nephi was 22.5 bushels per acre, but during this period the annual yields ranged from a total failure to 57 bushels per acre. The best variety of spring oats in the same years averaged 20.2 bushels.

Eperimental results at the Nephi substation show that winter oats yielded best when sown between October 1 and 15 at the rate of 7 or 8 pecks per acre and to a depth of 1 to 3 inches.

SPRING OATS.

Spring oats are not commonly grown on Utah dry farms. Varietal experiments at the Nephi substation show that if they are grown the midseason varieties yield best. The Swedish Select, Black American, and Big Four yielded better than Sixty-Day or Kherson, the latter being early varieties. Spring oats should be sown as early as the soil can be put in condition for sowing. Sow at the rate of 5 to 6 pecks per acre and cover the seed about 2 inches deep.

BARLEY.

Barley is not grown extensively on the Utah dry lands. Winter varieties are not hardy enough to be grown without considerable danger from winterkilling, and spring varieties are not adapted to Utah conditions. It is grown mostly for feeding, though some of that grown under irrigation is marketed.

The acreage devoted to barley in Utah is small when compared with that of either wheat or oats. In 1912 barley was grown on 25,000 acres, which produced 1,125,000 bushels. The acreage had increased to 34,000 in 1916, and the production to 1,224,000 bushels. The production in 1915 was 1,445,000 bushels.

WINTER BARLEY.

Winter barley is not commonly grown on Utah dry lands. At elevations above 4,000 feet winter barley is likely to winterkill. It is better adapted to the lower elevations than spring barley. When winter barley survives with a good stand it always yields higher than the spring varieties. Winter barley matures earlier, grows taller, and is more easily handled than spring barley.

At the Nephi substation the 8-year average yield of White Club winter barley was 23.3 bushels and that of Tennessee Winter was 21 bushels. This is about one-half more in pounds of grain than was

produced by winter oats. Better yields of these barleys should be obtained at lower elevations than that at Nephi.

Winter barley should be sown at the rate of 7 to 8 pecks per acre. Where winterkilling is severe, the rate of seeding should be increased. Sow when moisture conditions are favorable for quick germination. A good growth before winter begins is advantageous and increases the chances for a good crop. Sow from 1 to 3 inches deep for the best results. The seed-bed preparation should be the same as for winter wheat.

FIG. 8.—A Utah dry-farm cornfield. The cool nights at the high altitudes of these mountain valleys are not favorable for the growth of corn, as is evident from the dwarfing of this crop.

SPRING BARLEY.

Spring barley is not a profitable cash crop on Utah dry lands. Only the early-maturing varieties should be grown. The Coast, Mariout, and White Smyrna are the leading dry-land varieties in the intermountain sections. Spring barley is difficult to handle on the dry lands because of the short growth.

MINOR GRAIN CROPS.

CORN.

Corn is not extensively grown in Utah on the dry lands. If it were possible to grow corn profitably on the dry farms, the cropping system would undoubtedly change from wheat and fallow to wheat

and corn. Flint varieties do better on these dry lands than dent varieties. The Jumbo and White Australian are the most commonly grown varieties. Profitable yields are obtained on some of the dry-farmed soils in limited sections, but corn is not generally a profitable dry-land grain crop in Utah. The cool nights in the mountain valleys are unfavorable for growth and cause the dwarfing shown in figure 8.

Corn should not be planted until the danger from spring frost is past. Plant shallow on heavy soils and deeper on the lighter soils. Keep the cornland free from weeds. A thin stand is preferable.

GRAIN SORGHUMS.

Grain sorghums are not commonly grown on Utah dry farms. In the southern part of the State and on the light soils sorghums are grown with varying degrees of success. These crops, however, are not commercially grown in Utah. Dwarf milo, white kafir, and brown kaoliang are the most promising grain sorghums. Sorghums should not be seeded until late in the spring when the ground is warm and growth will not be checked by cool weather. They should be sown in rows and cultivated the same as corn.

PROSO.

Proso millets are not adapted to Utah conditions. All experimental data show that this crop can not be profitably grown on these dry lands.

FLAX.

Experimental results with flax have not been promising. It is doubtful whether flax is of much value on the dry lands, but at the lower altitudes and under irrigation it should be a very profitable crop. Flax should be sown about corn-planting time at the rate of 15 to 20 pounds per acre. Sow shallow and on clean ground.

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